THE SHORT-TERM LOAD FORECAST

1991-1996

Load Forecasts Department
Economics & Forecast Division
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THE DECEMBER 1991 SHORT-TERM LOAD FORECAST - 1991 TO 1996

1.0 Highlights

This report presents and documents the evolution of the 1991 Short Term Load Forecast. The Basic Load Forecast's growth rates were set in July but the 1991 estimated actual replaced the forecast value for 1991 in a December adjustment. The July demand management projection was updated in October to include for the first time the short-term impact of fuel-switching programs from electricity to gas. At the time the 1991 actual was incorporated (December), a small change was also made to load displacement NUG's in 1994-6. This report contains comparisons of these three versions of the 1991 Short-Term Load Forecast with the July 1990 forecast, approved as part of LF901210, and the January Update which formed the basis of the OEB submission for HR20.

The 1991 Short-Term Load Forecast is lower than the LF901210 forecast in all forecast years for both the weather-normal primary and basic energy. Basic energy (TW.h) is forecast to grow by 3.3 percent in 1992. The annual rate of growth for basic energy between 1991 and 1995 is 3.3 percent in this report which is about the same as in LF901210. However, the level of basic energy demand starts the period down 4.1 percent and ends down 3.9 percent from LF901210. The average level is down 4.5 percent for all years, with the greatest difference in 1992 when it is 5.4 percent less than LF901210.

Primary energy declined at 0.6 percent in 1991 (weather-corrected) and is expected to rise 2.6 percent in 1992. The annual rate of growth for primary energy between 1991 and 1995 is 2.6 percent in the present report, down from 2.7 percent for the same period in LF901210. The level of primary energy demand starts the period down 4.1 percent and ends down 4.6 percent from LF901210. The average level is down 4.7 percent for all years with, again, the greatest difference (5.4 percent) appearing in 1992. The larger reduction in primary energy as compared to basic energy between 1991 and 1995 may be attributed to the increased targets for EEI and fuel switching programs. The energy impact of EEI and fuel switching starts in 1991 at about 1.3 TWh and ends in 1995 at about 6.1 TWh, up by 1.6 TWh from LF901210's forecast.

1.1 Evolution of the 1991 Forecast

The evolution of the 1991 Load Forecast is outlined in this section. The forecast results for each of the projections made in 1991 are summarized in Table 1.1 along with the July 1990 forecast (LF901210).

LF901210 was produced at a time when the economic outlook was more optimistic. It assumed roughly flat GDP in 1990, 1.8 percent growth in 1991 and a rebound in 1992 which continued at a moderate level until 1995. Average growth over the entire period 1991 to 1995 was calculated at 3.5 percent. However, actual economic growth in 1990 was much weaker than anticipated, declining by about 0.8 percent over the previous year. The construction boom of 1987-1989 collapsed and new capital investment spending slowed substantially. In addition, major strikes in the steel and pulp and paper industries reduced total primary load in 1990 by around 1.0 percent. Actual primary load was therefore down by 2.9 percent in 1990 relative to 1989, while on a weather-normal basis, the load was down by 0.9 percent.

Table 1.1 Comparison of the Short-Term Energy (GWH) Forecasts

Basic Energy

Year	LF901210		OEB Update		Jul'91		Oct. ' 91		Dec. '91	
	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)
1991	145330		141448		141427		141431		139367	
1992	152160	4.7	146078	3.3	146059	3.3	146059	3.3	143929	3.3
1993	156137	2.6	150777	3.2	150762	3.2	150767	3.2	148570	3.2
1994	160446	2.8	156813	4.0	155739	3.3	155741	3.3	153471	3.3
1995	165281	3.0	163085	4.0	161190	3.5	161188	3.5	158838	3.5
1996			170067	4.3	167450	3.9	167449	3.9	165008	3.9
1991-1995		3.3		3.6		3.3		3.3		3.3
1991-1996				3.8		3.4		3.4		3.4

Primary Energy

Year	LF901210		OEB Update		Jul'91		Oct. '91		Dec. '91	
	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)
1991	143516		139753		139710		139736		137672	
1992	149436	4.1	143413	2.6	143400	2.6	143438	2.6	141301	2.6
1993	152415	2.0	147009	2.5	146834	2.4	146929	2.4	144748	2.4
1994	155790	2.2	151975	3.4	150374	2.4	150477	2.4	148590	2.7
1995	159745	2.5	157178	3.4	154622	2.8	154302	2.5	152476	2.6
1996			162998	3.7	159810	3.4	158580	2.8	156522	2.7
1991-1995		2.7		3.0		2.6		2.5		2.6
1991-1996				3.1		2.7		2.6		2.6

EEI

Year	LF901210		OEB Update		Jul'91		Oct. '91		Dec. '91	
	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)
1991	1295		1212		1280		1257		1257	
1992	2065	59.5	2042	68.5	2387	86.5	2320	84.6	2320	84.6
1993	2852	38.1	2934	43.7	3571	49.6	3351	44.4	3351	44.4
1994	3668	28.6	3850	31.2	4747	32.9	4310	28.6	4310	28.6
1995	4513	23.0	4779	24.1	5775	21.7	5331	23.7	5331	23.7
1996			5806	21.5	6777	17.4	6621	24.2	6621	24.2
1991-1995		36.6		40.9		45.7		43.5		43.5
1991-1996				36.8		39.6		39.4		39.4

Fuel Switching

Year	LF901210		OEB Update		Jul'91		Oct. '91		Dec. '91	
	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)
1991	0		0		0		0		0	
1992	0	-	0	-	0	-	28	-	28	
1993	0	-	0	-	0	-	131	367.9	131	367.9
1994	0	-	0	-	0	-	337	157.3	337	157.3
1995	0	-	0	-	0	-	761	125.8	761	125.8
1996			0	-	0	-	1384	81.9	1384	81.9
1991-1995		-		-		-		-		-
1991-1996				-		-		-		-

LD-NUG

Year	LF901210		OEB Update		Jul'91		Oct. '91		Dec. '91	
	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)	(GWH)	(%)
1991	519		484		438		438		438	
1992	659	27.0	624	28.9	273	-37.7	273	-37.7	281	-35.8
1993	869	31.9	834	33.7	357	30.8	357	30.8	340	21.0
1994	988	13.7	988	18.5	618	73.1	618	73.1	235	-30.9
1995	1023	3.5	1128	14.2	793	28.3	793	28.3	270	14.9
1996			1261	11.8	863	8.8	863	8.8	480	77.8
1991-1995		18.5		23.6		16.0		16.0		-11.4
1991-1996				21.1		14.5		14.5		1.8

OEB Submission (January 1991)

The overall economic situation remained fairly grim at the time when the Load Forecast was updated for the Ontario Energy Board Submission in January 1991 (see Appendix 1). Ontario GDP was then anticipated to register negative growth rates of 0.6 percent and 0.4 percent in 1990 and 1991 respectively, which was a significant change from the September 1990 forecast. The reduced growth in 1990 and 1991 was offset by a faster rate of recovery, with the result that GDP at the end of the short-term forecast was close to the long-term trend value used in LF901210. The January 1991 forecast took into account the changes in economic outlook and a revision to the net load impacts of EEI, L-S AND LD-NUG programs that was prepared in November 1990. The load forecast was reviewed in April 1991 to assess whether an Update was required for HR20 but no further revision was considered appropriate at that time.

July 1991 Forecast

In July 1991, the Basic Load Forecast was reviewed for 1992 rate finalization purposes. It took into consideration the following:

- the 1991 Customer Estimates, completed individually in April and May and compiled in early July;
- the results of the monthly Box-Jenkins and State-Space models using weather corrected load data to June 1991;
- the results of the annual econometric models with the 1990 data excluded;
- the latest estimates for the net load impact of EEI, L-S and LD-NUG (prepared in July 1991); and
- a revised electricity price forecast.

By July, real GDP was assumed to decline 1.6 percent in 1991. From 1992 onward, it was forecast to recover so that by the end of the short-term forecast horizon it would nearly return to the long-term trend value used in January 1991. The price of electricity was projected to be about 15.3 percent higher in real terms in 1995 than the 1991 level, compared to a 13.2 percent increase forecast in HR20. The extra few percent electricity price increase has a small negative impact on the energy forecast in the short term.

In the July 1991 forecast, the EEI energy impact starts in 1991 at about 1.3 TWh and ends in 1995 at about 5.8 TWh, up by 1.3 TWh from LF901210's estimates. The estimated contribution of the Load Shifting program, including Time-of-Use Rates, has been revised downwards for all the five years. The Load Displacement Non-Utility Generation Program impact has also been revised downward. This is because of a major shift by the applicant generators toward sales to Hydro through a third party and away from simple displacement of their own load. The net impact of all these changes on demand management programs and load displacement generation for 1995 was a reduction in annual primary peak of 111 MW and a reduction in annual energy of 1.0 TWh, both relative to LF901210.

October 1991 Forecast

The 1991 Short-Term Load Forecast done in October 1991 differs from the July 1991 forecast solely in that it includes the energy impact of the fuel switching option (see Table 4.1). The energy impact of the EEI programs was also revised since the switchover from electric heating to natural gas reduces EEI potential. Relative to LF901210, the net impact of all these changes in demand management programs and LD-NUG for 1995 is a reduction in primary December peak of 438 MW and a reduction in primary energy of 1.4 Twh. Compared with the July 1991 forecast, there is no change in basic energy and basic peak throughout the forecast horizon. By 1995 the October forecast has a December primary peak which is 327 MW lower and annual energy which is 0.3 TW.h lower than the July forecast. The basic peak occurs in December in 1995 and 1996 but the primary peak occurs in January in the October forecast. The shift in primary peak to January results from the large growth in the fuel switching component.

December 1991 Forecast

The OEB submission for HR21 contains the short-term forecast as of December 1991. The major change relative to the October 1991 forecast is a reduction in the primary and basic load levels of 1.5 percent in 1991, adjusting for the extent of the expected over-forecast for 1991. The growth rates for Basic Load between 1992 and 1996 remain the same as in the July load forecast. The primary load forecast has slightly higher growth due to a reduction in the forecast of LD-NUG.

2.0 Inputs to the July Basic Load Forecast

The Basic Load Forecast is the forecast of the demand for electricity without taking into account the net impact of Hydro's incentive-driven programs to influence the level and timing of electricity demands on Ontario Hydro. The Basic Load Forecast however does take into account energy efficiency improvements, fuel switching and load displacement non-utility generation that are driven by normal market forces. The July forecast is the major annual short-term load forecast due to the once annual inclusion of customer forecast information and the rate finalization that results.

The July short-term basic load forecast is annually prepared considering the following information.

(1) Regional Estimates - Each year a survey is made of all the Corporation's customers to determine their expectations for their own future peak demand. Known future customers are also taken into account.

(2) Economic Conditions and Trends - The most recent economic activity and energy price forecasts are assessed directly as well as used as inputs to a range of models for forecasting electricity demand.

(3) Forecasting Models - The Load Forecasts Department has estimated a variety of single-equation annual econometric models and monthly time series models. They range from

purely statistical analysis of past data (Box-Jenkins) to conventional structural econometric specifications. No one model has developed a clearly superior track record over the whole term of the forecast.

These three sources of forecast information are supplemented by other indicators where available (such as results from the end-use models).

This section provides a brief description of each of the above inputs. The forecast models are discussed in more detail in Appendix 2.

2.1 Regional Estimates

To initiate the short-term forecasting process, the Load Forecasts Department asks the regional offices to provide six years of estimates of the peak for each wholesale customer (municipalities and direct industrial) and total retail customers. The regional staff are supplied with the results from two time-series models provided by the Load Forecasts Department. With their knowledge of the local economy and the results of their consultation with large customers, they prepare an estimate for each month of the current year and the first forecast year. For the subsequent four years, only December forecasts are made. The customer survey takes place between February and May each year.

The municipal utilities, the area offices, and the direct customers have the best and most detailed information about plans in their own neighbourhood and businesses. They have the best perspective on new developments requiring electricity, on local business anomalies and on the continuity of existing sales. Their estimates are believed to be quite reliable for the near term.

The regional estimates, which form the starting point for the regional detail for the Short-Term Forecast, were down 7.6 percent in 1991 and down 11.0 percent in 1995 compared with LF901211. The substantially lower estimates given by the customers indicate that they are much less optimistic than they were last year. It has been observed that the regional estimates tend to reflect recent trends in electricity use. For the medium term their forecasts may be over-reacting to the economic conditions at the time when the forecast was made. In selecting the recommended forecast, the customers' low forecast was discounted somewhat in the 3 to 5 year ahead period. (See Table 3.1).

Table 2.1 Sum of Customers' Loads - MW

Average Monthly 1-Hour Non-Coincident Peaks

Year	1991 Customer Survey	1990 Customer Survey	Differences	% Change
1991	21252	22998	-1746	-7.6
1992	22016	23973	-1957	-8.2
1993	22740	25042	-2302	-9.2
1994	23471	26114	-2643	-10.1
1995	24171	27172	-3001	-11.0
1996	24881	N/A	N/A	N/A

2.2 Economic Conditions and Trends

2.2.1 Economic Outlook

The January 1991 forecast of Ontario real GDP growth for 1991 and 1992 was -.4 and 3.0 percent respectively. From 1993-96 projected real economic growth averaged between 4.0 and 4.5 percent.

The September 1991 forecast of Ontario real GDP growth for 1991 and 1992 was set at -1.6 percent and 3.9 percent respectively. Beyond 1992, Ontario real economic growth is expected to accelerate to 4.0 percent in 1993 and further to 4.5 percent in 1994 and 4.0 percent in 1995. This is a customary pattern of expansion in the recovery phase of the business cycle although the growth rates are weaker than those attained in the recoveries of 1976 and 1983.

Table 2.2 Economics and Forecasts Division's Outlook

Ontario Real Domestic Product - $1986 Million**

Year	Jan. 1991*	% Increase	Sept. 1991	% Increase	Difference Jan. '91/Sept. '90
1990	229,293	-0.6	229,293	-0.6	0.0
1991	228,357	-0.4	225,624	-1.6	-1.2
1992	235,207	3.0	234,424	3.9	-0.3
1993	244,616	4.0	243,801	4.0	-0.3
1994	255,623	4.5	254,869	4.5	-0.3
1995	265,849	4.0	265,064	4.0	-0.3
1996	277,812	4.5	276,992	4.5	-0.3

* Data include revisions associated with rebasing Ontario GDP to 1986 dollars from 1981 dollars.

** Forecasts are from the Short-Term Economic Forecast, January 1991 and September 1991.

2.2.2 Energy Price Trends

Electricity prices are projected to increase by about 15.3 percent in real terms by 1996. In the last OEB submission, (HR20) real electricity prices were projected to rise by 13.2 percent over the same time period.

The natural gas market has been very weak in the last few years. Deregulation and deliverability limitations on the pipeline systems have depressed domestic prices to levels not seen in 10 years. The weakness will remain through 1993; prices are then expected to improve in 1994 to 1996 due to export growth.

2.3 Short-Term Forecasting Models

Several varieties of time series and econometric models have been built to assist with the forecasting process. The most sophisticated time series model, the State-Space, incorporates Ontario GDP and residential building permits by month as explanatory variables. The econometric models, built on annual data, incorporate both a time series and an economic component. They also build in explanatory economic variables including prices of electricity and natural gas.

Greater detail concerning the model development, specification and forecasts is given in Appendix 2.

Table A2 in the appendix presents a comparison of the model projections along with the regional estimates and other forecast information used to determine the Short-Term Load Forecast.

2.3.1 Monthly Models

For several years the Load Forecasts Department has been gaining experience with several more advanced forecast modelling techniques. These use monthly weather-corrected data and comprise single and multiple variable time series methods. The forecasts prepared using these techniques perform best for time horizons less than about 18-24 months.

Since January 1988, the Load Forecasts Department has adopted a weather-correction methodology which adjusts for wind speed, illumination and humidity in addition to the temperature effects previously taken into account. This methodology was used to create a historical time-series of monthly weather-corrected data load data that goes back to 1971. The best models estimated by EPRI's Forecast Master Plus software using these data have considerably better fits than the best models possible with actual data, attempting to account for weather effects within the equation itself. The methodology used to weather-correct actual load data is described in Appendix 3.

The single variable time series model, called the Box-Jenkins technique after the original developers, presumes that all the information relevant to predicting the future of a variable is contained within the data history of the series to be predicted. Box-Jenkins models may be expected to forecast well in periods when the factors which affect the variable being forecasted

continue their recent trend. For economic data this is unlikely to be longer than about two years and is often considerably less time. Predicted changes to the background environment of the forecasted variable that are out of keeping with recent trends will not be reflected in the projection made by the Box-Jenkins models. For this reason, little weight is currently being given to the Box-Jenkins forecast.

Multivariate time series methods are an elaboration of the single variable technique which permit key causal variables to be included in the forecasting equation. The form of multivariate time series analysis which is used by the Load Forecasts Department is called State-space modelling. The State-space model's forecast is still dominated by recent patterns in electricity use; a forecasted change in the trend of GDP growth has less impact on the forecast during the first year than the same change would have in one of the annual econometric models. Tests done on the State-space model with actual data in various time periods show that it reacts strongly to recent changes in pattern and growth. Due to its response, its projections are to be tempered by judgement in times of rapid but transient change in pattern.

The State-space model used in the 1991 Load Forecast has used Ontario GDP and the value of residential building permits as explanatory variables. The dependent variable is the time-series of the historical values for monthly weather-corrected Ontario basic energy. Until the end of 1988, basic load and primary load data are the same. From 1989 onward, basic energy is obtained from the observed primary load data by adjusting the primary energy series for the estimated net impact of Hydro's demand management efforts.

In order that the load lost temporarily due to strikes between August and December 1990 would not unduly bias the forecasts for 1991, the estimated impact of the strike was restored to the observed load for modelling purposes only. These estimates were derived in consultation with Regional staff familiar with the affected industry.

The model has been quite sensitive to the economic downturn experienced in the province in 1990 and 1991 and has responded to the downward revision in GDP and housing starts in the economic outlook. In July the model was projecting basic growth of 0.8 percent for 1991, 3.1 percent for 1992 and 2.7 percent for 1993.

2.3.2. Annual Models

The annual econometric models were estimated on basic energy data that are not weather-corrected as heating and cooling degree day variables are included as explanatory variables in the equations.

The year 1990 was excluded to avoid distortions to the forecast as it was judged to be a year with extreme weather effects, and major labour disruptions. In part this was motivated by the experience of the 1980's when forecasts made just prior to the recession year 1982 performed better in the mid-1980's than the ones made just after the recession.

No specification changes were made to the partial adjustment and error correction models relative to LF901210. The error correction model starts with a 2.0 percent growth for 1991.

The average annual rate of increase for the period 1991-1996 is 3.1 percent. The partial adjustment model starts with a 1.5 percent growth for 1991. The average annual rate of increase for the same period is 3.0 percent.

3.0 Determining the Short-Term Basic Load Forecast and the Unallocated Load

The customer surveys, economic trends and forecast model results constitute most of the data used in generating the forecast, but any other indicators of economic performance and electricity sales are considered as well. The Recommended Basic Forecast is finally derived by considering all available information taking into account the suitability of each methodology for projecting particular years of the forecast period.

The July Basic Load Forecast did not revise the growth rates used in the OEB submission for 1991, 1992 and 1993. The rationale for the growth rates projected in January 1991 is given in the memo reproduced in Appendix 1. The decision to keep the same growth rates for 1991-93 in July 1991 reflected several pieces of information that were available at that time. As of July, the January Forecast (OEB submission) was on target for 1991. Also, the customer's basic energy forecast for 1992 and 1993 was within 9 Av. MW and 18 Av. MW respectively of the recommended levels in the January 1991 Forecasts. Finally, the results of the annual models still confirmed the basic energy levels projected for 1992 and 1993. The July forecast was marginally lower than the OEB submission between 1994 and 1996 due to higher electricity prices.

The 1991 Basic Load Forecast starts with 1.5 percent growth for 1991, 3.0 percent for 1992 and an average of 3.5 percent over the remaining years.

Table 3.0 The 1991 July Basic Load Forecast

	December 1-Hour Peak			Energy					
		Annual Growth				Annual Growth			
Year	MW	MW	%	Av. MW	TW.h	Av. MW	%	TW.h	%
1990	24488	964	4.1	15909	139.4*	-60	-0.4	-0.5	-0.4
1991	24036	-452	-1.8	16145	141.4	236	1.5	2.1	1.5
1992	24704	668	2.8	16628	146.1	483	3.0	4.6	3.3
1993	25635	931	3.8	17211	150.8	583	3.5	4.7	3.2
1994	26488	853	3.3	17779	155.7	568	3.3	5.0	3.3
1995	27459	971	3.7	18400	161.2	622	3.5	5.4	3.5
1996	28514	1055	3.8	19063	167.4	663	3.6	6.3	3.9
Av. Increase									
1990-1995		594	2.3			498	3.0	4.4	3.0
1991-1996		896	3.5			584	3.4	5.2	3.4

*Weather-Corrected Actual

3.1 Unallocated Load

The 1991 Customer Survey resulted in energy growth forecasts of 0.9 percent for 1991, 3.6 percent for 1992 and an average of 3.1 percent over the remaining years.

To make the total of the Customer Estimates reconcile to the Basic Load Forecast, an amount must be added or subtracted. This is called the Unallocated Load. It is not allocated to particular customers, but is applied on a customer class and regional level of disaggregation to the customer estimates.

The amounts of unallocated load in this year's forecast are relatively small compared with those in LF901210. The customer estimate and our load forecast are almost identical in 1991 and 1992, although they do diverge from 1993 onward. Throughout the short-term forecast period, the Recommended Basic Load Forecast done in July is higher than the customers estimate. For a comparison of the July basic load forecast relative to the customer forecasts see Table B2.1 in Appendix II.

Table 3.1 Sum of Customer's Loads - MW

	Basic Average Monthly 1-Hour Non-Coincident Peaks		
Year	Customer Survey	Unallocated Load	Load Forecast
1991	21252	136	21388
1992	22016	1	22017
1993	22740	68	22808
1994	23471	104	23575
1995	24171	239	24410
1996	24881	432	25313

3.2 Weather

The Short-Term Forecast includes monthly forecasts of energy and peak demand. The monthly actual demands, as well as the annual actual totals, are strongly influenced by weather conditions. For the purpose of the forecast, normal weather conditions, as measured by the recorded averages, are assumed. For example, the December peak is assumed to occur on the most extreme weather day in December, which is assumed to have temperature, wind and illumination conditions equal to the typical extreme day in December.

3.3 Losses

In addition to estimates of customer demand, transmission losses are incorporated in the Basic Load Forecast. These losses averaged approximately 4.0 percent of customer energy for 1981 to 1983. Since 1984 losses gradually increased due to the delay in obtaining adequate transmission out of the Bruce nuclear complex. With the new 500 kv line from Bruce coming into service by the year end of 1990, forecast energy losses for 1991-1996 are assumed to reduce again, to the range of 4.2 to 4.4 percent.

4.0 Derivation of The Short-Term Primary Load Forecast

The Primary Load Forecast is derived by subtracting the net program impacts from the Basic Load Forecast. It is the forecast of power and energy which Ontario Hydro generates or purchases in order to meet the demands of its customers in Ontario. It incorporates the net impact of program-driven demand management and load displacement non-utility generation. The derivation of the Primary load forecast from the Basic load forecast is summarized in Table 4.1.

4.1 Impact of the EEI, FS, L-S and LD-NUG Programs

Electrical generation that is not owned or operated by Ontario Hydro and that is consumed by the generating customer reduces the demand on Ontario Hydro's system. It is known as load displacement non-utility generation (LD-NUG). Nearly all industrial cogeneration currently in operation in Ontario falls into this category. The LD-NUG estimates are lower than last year to the Short-Term Forecast horizon since program participants have opted to become suppliers of generation to Ontario Hydro rather than becoming load displacement generators. Generation is considered a supply resource for planning purposes, and does not impact on the Load Forecast.

The energy impact of the new fuel switching program has also been incorporated explicitly in the 1991 load forecast. The fuel switching programs envisaged provide financial incentives to customers to switch from electricity to natural gas. They would apply to space and water heating in the residential sector and space heating in the commercial sector. Attainable fuel switching potential of about 1.4 TWh was identified in the residential and commercial sector by 1996.

Because of fuel switching, some of the load which is otherwise available for EEI is displaced. The potential induced EEI therefore is reduced to about 6.6 TWh in 1996. In total, the cumulative impact for EEI and FS is expected to reach 8.0 TWh at the end of the short-term forecast.

The estimated impact of the load-shifting (L-S) programs by 1995 has been reduced from 532 MW in LF901210 to 397 MW in this forecast.

4.1.1 Derivation of 1990 Basic from Primary

The analysis of trends in Basic load requires sound estimates of Basic load in years where demand management has had a noticeable impact on the observed primary load data. The approach is straightforward, in principle: simply add to the primary actual load the estimated net load impact of demand management to date. This was done for energy using the values given in Table 4.1.

Table 4.1 Derivation of Primary from Basic - December 1991 Short-Term Load Forecast

December Primary Peak - MW - 1-Hour

Year	Basic	EEI	FS	L-S	LD-NUG	Primary
1990	22813	147		116	59	22491*
1991	23686	334		174	60	23118**
1992	24344	526	24	221	38	23535
1993	25262	714	74	276	46	24151
1994	26102	869	169	334	31	24699
1995	27059	1112	376	397	36	25138***
1996	28099	1347	574	461	64	25653***
Avg. Increase						
1990-95	3.5					2.2
1991-96	3.5					2.1

* See 4.1.1.

** See 4.2 discussion on 1991 peak forecast.

*** The January projected peaks are 25222 MW in 1995 and 25715 MW in 1996, see 4.2.

Energy - GWH

		Annual Growth						
Year	Basic	GWH	%	EEI	FS	L-S	LD-NUG	Primary
1990	139367	-522	-0.4	537	0	0	343	138487
1991	139367	0	0.0	1257	0	0	438	137672
1992	143929	4562	3.3	2320	28	0	281	141301
1993	148570	4641	3.2	3351	131	0	340	144748
1994	153471	4901	3.3	4310	337	0	235	148590
1995	158838	5367	3.5	5331	761	0	270	152476
1996	165008	6170	3.9	6621	1384	0	480	156522
Avg. Increase								
1990-95		3894	2.6					1.9
1991-96		5128	3.4					2.6

1990 Primary is W/C Actual. The 1990 Primary Actual without W/C is 136743 GWH.
1990 Primary Actual was 136743 GWH.

Energy - Av MW

		Annual Growth						
Year	Basic	Av MW	%	EEI	FS	L-S	LD-NUG	Primary
1990	15909	-60	-0.4	61	0	0	39	15809
1991	15909	0	0.0	143	0	0	50	15716
1992	16385	476	3.0	264	3	0	32	16086
1993	16960	575	3.5	383	15	0	39	16524
1994	17520	560	3.3	492	38	0	27	16962
1995	18132	613	3.5	609	87	0	31	17406
1996	18785	653	3.6	754	158	0	55	17819
Avg. Increase								
1990-95		445	2.6					1.9
1991-96		575	3.4					2.5

1990 Primary is W/C Actual. The 1990 Primary Actual without W/C is 15610 Av MW.

Basic peak may be derived in a similar fashion. However, there is an added complication in that the month of the year in which the Basic peak occurs can vary for the reasons related to Basic energy growth rates, and the month of the year in which Primary load peaks may differ from the month the Basic peaks depending on the relative magnitude of demand management impacts and the Basic load change. The weather-corrected primary peak of 24166 MW for 1990 occurred in January largely because the recession depressed load later in the year. For consistency and to incorporate the year-end DSM estimates, in Table 4.1 the peak results are all reported for December. The Weather-corrected primary peak in December was 22491 MW which yields a basic peak of 22813 MW.

The actual peak for the year without weather-correction occurred in February and was 22272 MW.

4.2 The December 1991 Short-Term Primary Load Forecast

The December 1991 Short-term Primary Load Forecast for the total system is summarized in Table 4.2.

Table 4.2 The Short-Term Primary Load Forecast

	December 1-Hour Peak			Energy					
		Annual Growth				Annual Growth			
Year	MW	MW	%	Av. MW	TW.h	Av. MW	%	TW.h	%
1990	22491	-877	-3.8	15809	138.5	-145	-0.9	-1.3	-0.9
1991	23118	627	2.8	15716	137.7	-93	-0.6	-0.8	-0.6
1992	23535	417	1.8	16086	141.3	370	2.4	3.6	2.6
1993	24151	616	2.6	16524	144.7	438	2.7	3.4	2.4
1994	24699	548	2.3	16962	148.6	439	2.7	3.8	2.7
1995	25138	439	1.8	17406	152.5	444	2.6	3.9	2.6
1996	25653	515	2.0	17819	156.5	413	2.4	4.0	2.7
Av. Increase									
1990-1995		529	2.2			319	1.9	2.8	1.9
1991-1996		507	2.1			421	2.5	3.8	2.6

Because of time restrictions, the December 1991 adjustment was not a full forecast update. It was simply a level change in base year peak and energy; no fine-tuning of the monthly pattern was done nor were forecast growth rates reconsidered. The December 1991 forecast incorporates the estimated actual for 1991 as its new base year value and has the same basic growth rates for 1992 to 1996 as the July and October forecasts. Fuel switching was introduced in October resulting in a lower primary growth rate relative to the July forecast. Other than the change to the level in the base year, the only difference from October is a lower value for LD-NUG's in December which results in a slightly higher primary growth rate. Since this forecast was prepared, the 1991 weather-corrected actuals were released: for energy 137.6 TW.h, and

for December peak, 22773 MW. The peak for the year occurred in January and was 23883 MW.

The above table shows the weather-corrected actuals for 1990 and weather-normal energy and December peak forecasts for 1991-1996. Actual Primary load in 1991 was 137.0 TW.h. Warm weather in the winter months resulted in a weather-corrected Primary load of 137.7 TW.h (early December estimate). This is 1.5 percent below the July 1991 load forecast. As of July, the January forecast (which underlay the submission for HR20) was on target. However, load growth between September and December did not show the year-over-year growth that was expected, resulting in the error at the annual level. Given the strikes and the weakness of the economy in the fall of 1990, moderate year-over-year growth had been anticipated.

The December peak forecast was used in Table 4.2 to facilitate consistent comparisons. The peak was considerably lower in December than in January due largely to the recession and to a lesser degree to the impact of DSM programs. In both 1995 and 1996, the annual peak is also projected to occur in January rather than December. The shift is due to the fuel switching program which reduces winter peak significantly in both years, and when combined with the other demand management, outpaces the yearly basic winter peak growth.

4.3 Discount Demand Service (formerly Capacity Interruptible Loads)

The Discount Demand Service is a rate structure under which a customer contracts for electricity which Ontario Hydro has the right to interrupt, subject to certain restrictions. In return for lower reliability the customer pays a lower price for the electricity consumed. Interruptible loads and any other Control Centre Controlled loads are subtracted from the Primary Load Forecast when System Planning derives the Firm Load Forecast.

The interruptible loads forecast under the Discount Demand Service in 1991 shows a sharp reduction from 1990's forecast. This decline, averaging 40%, follows a reduction of about 8% in 1990 from 1989's figures. It is attributable to a shift by customers to firm power to support increasingly sensitive processes where the cost of interruption has been found to be high, and to a general reduction in forecasts across the whole direct customer class. In addition, there was a perception that the risk of interruption had increased. Since the residual above the firm power contracted is the DDS interruptible, a moderate reduction in a customer forecast leads to a large proportional year over year change in the DDS portion.

Of the roughly 250 MW of reduction in the average of monthly peaks in terms of generation, from about 650 MW to about 400 MW, 40 MW is attributable solely to a shift in the coincidence factor with system peak. Experience and recent measurements have shown that the amount of interruptible available at time of peak is less than that obtained in years past, due to greater diversity in time. A coincidence factor of 0.68 for the East System has been employed in preparation of this forecast.

Table 4.3.1 **Sum of Non-Coincident Customers' Discount Demand Service Load December Monthly Peak - MW**

	1991	1992	1993	1994	1995	1996
Interruptible MW	577	538	543	552	565	573

Table 4.3.2 **Discount Demand Service Load In terms of Generation (coincident with East System Peak)**

	1991	1992	1993	1994	1995	1996
Interruptible MW	423	382	405	409	425	424

Note re: 25 Hz. There are less than four 25 Hz DDS customers and their load is less than 10% of the DDS amount.

Currently only one customer in the West System has a DDS service. The December interruptible load in terms of generation is 32 MW in 1991, 33 MW in 1992, and 37 MW in later years.

5.0 Forecast Comparisons

5.1 Comparison of 1991 Short-Term Forecasts with LF901210 - Peak Demand

Table 5.1 presents the peak demand comparison of the December 1991 Forecast with LF901210 (July 1990), the OEB Submission (January 1991), July 1991 and October 1991 forecasts.

The level of December primary peak forecast in 1995 is 6.5 percent or 1751 MW lower than projected in LF901210. The January or annual peak forecast in 1995 is 6.2 percent lower than the annual peak projected in LF901210.

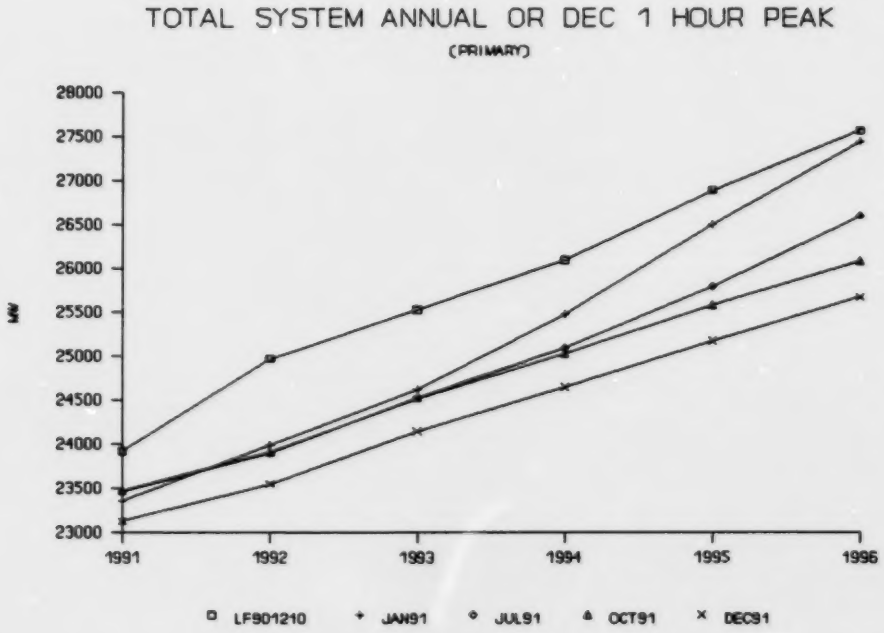

Table 5.1 Comparison of the Short-Term Peak Load (MW) Forecasts

Basic Dec 1 Hr Peak

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)
1991	24483		23901		24036		24036		23686	
1992	25765	5.2	24774	3.7	24704	2.8	24704	2.8	24344	2.8
1993	26577	3.2	25667	3.6	25635	3.8	25635	3.8	25262	3.8
1994	27400	3.1	26782	4.3	26488	3.3	26487	3.3	26102	3.3
1995	28442	3.8	28066	4.8	27459	3.7	27459	3.7	27059	3.7
1996			29302	4.4	28514	3.8	28514	3.8	28099	3.8
1991-1995		3.8		4.1		3.4		3.4		3.4
1991-1996				4.2		3.5		3.5		3.5

Primary Dec. 1 Hr Peak

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)
1991	23922		23361		23468		23480		23118	
1992	24968	4.4	23992	2.7	23897	1.8	23907	1.8	23535	1.8
1993	25525	2.2	24624	2.6	24529	2.6	24521	2.6	24151	2.6
1994	26097	2.2	25480	3.5	25094	2.3	25032	2.1	24699	2.3
1995	26889	3.0	26499	4.0	25795	2.8	25468	1.7	25138	1.8
1996			27441	3.6	26598	3.1	26016	2.2	25653	2.0
1991-1995		3.0		3.2		2.4		2.1		2.1
1991-1996				3.3		2.5		2.1		2.1

EEI

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)
1991	277		261		334		334		334	
1992	419	51.3	408	56.3	549	64.4	526	57.5	526	57.5
1993	568	35.6	564	38.2	782	42.4	714	35.7	714	35.7
1994	722	27.1	721	27.8	977	24.9	869	21.7	869	21.7
1995	883	22.3	882	22.3	1161	18.8	1112	28.0	1112	28.0
1996			1069	21.2	1339	15.3	1347	21.1	1347	21.1
1991-1995		33.6		35.6		36.5		35.1		35.1
1991-1996				32.6		32.0		32.2		32.2

Fuel Switching

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)
1991	0		0		0		0		0	
1992	0	-	0	-	0	-	24	-	24	
1993	0	-	0	-	0	-	74	208.3	74	208.3
1994	0	-	0	-	0	-	169	128.4	169	128.4
1995	0	-	0	-	0	-	376	122.5	376	122.5
1996			0	-	0	-	574	52.7	574	52.7
1991-1995		-		-		-		-		-
1991-1996				-		-		-		-

L-S

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)
1991	214		214		174		174		174	
1992	289	35.0	289	35.0	221	27.0	221	27.0	221	27.0
1993	367	27.0	367	27.0	276	24.9	276	24.9	276	24.9
1994	448	22.1	448	22.1	334	21.0	334	21.0	334	21.0
1995	532	18.8	532	18.8	397	18.9	397	18.9	397	18.9
1996			622	16.9	461	16.1	461	16.1	461	16.1
1991-1995		25.6		25.6		22.9		22.9		22.9
1991-1996				23.8		21.5		21.5		21.5

LD-NUG

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)
1991	70		65		60		60		58	
1992	89	27.1	84	29.2	37	-38.3	37	-38.3	38	-34.5
1993	117	31.5	112	33.3	48	29.7	48	29.7	46	21.1
1994	133	13.7	133	18.8	83	72.9	83	72.9	31	-32.6
1995	138	3.8	152	14.3	106	27.7	106	27.7	36	16.1
1996			170	11.8	116	9.4	116	9.4	64	77.8
1991-1995		18.5		23.7		15.3		15.3		-11.2
1991-1996				21.2		14.1		14.1		2.0

5.2 Comparison of 1991 Short-Term Forecasts with LF901210 - Energy Demand

Table 5.2 and Table 5.3 present the energy demand comparison of the December 1991 Forecast with LF901210, January 1991, July 1991 and October 1991 forecasts.

The level of primary energy forecast in 1995 is 4.6 percent or 7.3 TWh lower than that in LF901210.

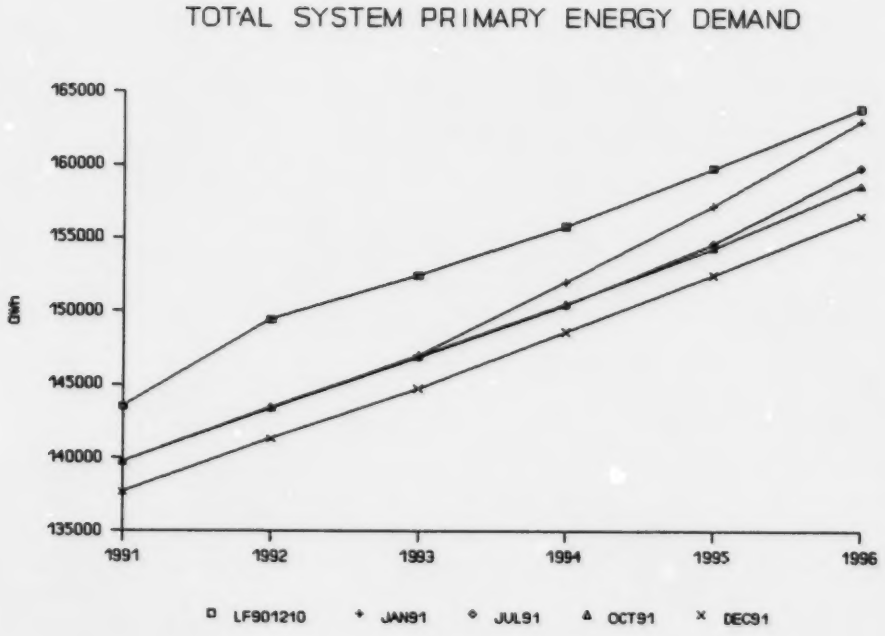

Table 5.2 Comparison of the Short-Term Energy (Av MW) Forecasts

Basic Energy

Year	LF901210		Jan '91		Jul'91		Oct. ' 91		Dec. '91	
	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)
1991	16590		16147		16145		16145		15909	
1992	17322	4.4	16630	3.0	16628	3.0	16628	3.0	16385	3.0
1993	17824	2.9	17212	3.5	17210	3.5	17211	3.5	16960	3.5
1994	18316	2.8	17901	4.0	17778	3.3	17779	3.3	17520	3.3
1995	18868	3.0	18617	4.0	18401	3.5	18400	3.5	18132	3.5
1996			19361	4.0	19063	3.6	19063	3.6	18785	3.6
1991-1995		3.3		3.6		3.3		3.3		3.3
1991-1996				3.7		3.4		3.4		3.4

Primary Energy

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)
1991	16383		15954		15949		15952		15716	
1992	17012	3.8	16326	2.3	16325	2.4	16329	2.4	16086	2.4
1993	17399	2.3	16782	2.8	16762	2.7	16773	2.7	16524	2.7
1994	17784	2.2	17349	3.4	17166	2.4	17178	2.4	16962	2.7
1995	18236	2.5	17943	3.4	17651	2.8	17614	2.5	17406	2.6
1996			18556	3.4	18193	3.1	18053	2.5	17819	2.4
1991-1995		2.7		3.0		2.6		2.5		2.6
1991-1996				3.1		2.7		2.5		2.5

EEI

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)
1991	148		138		146		143		143	
1992	235	58.8	232	68.1	272	86.3	264	84.6	264	84.6
1993	326	38.7	335	44.4	408	50.0	383	45.1	383	45.1
1994	419	28.5	439	31.0	542	32.8	492	28.5	492	28.5
1995	515	22.9	546	24.4	659	21.6	609	23.8	609	23.8
1996			661	21.1	772	17.1	754	23.8	754	23.8
1991-1995		36.6		41.0		45.8		43.7		43.7
1991-1996				36.8		39.5		39.4		39.4

Fuel Switching

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)
1991	0		0		0		0		0	
1992	0	-	0	-	0	-	3	-	3	
1993	0	-	0	-	0	-	15	400.0	15	400.0
1994	0	-	0	-	0	-	38	153.3	38	153.3
1995	0	-	0	-	0	-	87	128.9	87	128.9
1996			0	-	0	-	158	81.6	158	81.6
1991-1995		-		-		-		-		-
1991-1996				-		-		-		-

LD-NUG

Year	LF901210		Jan '91		Jul'91		Oct. '91		Dec. '91	
	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)	(AV.MW)	(%)
1991	59		55		50		50		50	
1992	75	27.1	71	29.1	31	-38.0	31	-38.0	32	-36.0
1993	99	32.0	95	33.8	41	32.3	41	32.3	39	21.9
1994	113	14.1	113	18.9	71	73.2	71	73.2	27	-30.8
1995	117	3.5	129	14.2	91	28.2	91	28.2	31	14.8
1996			144	11.6	98	7.7	98	7.7	55	77.4
1991-1995		18.7		23.8		16.1		16.1		-11.3
1991-1996				21.2		14.4		14.4		1.9

APPENDIX I

MEMO ON FORECAST OF ELECTRICITY SALES FOR 1991 TO 1996

ntario Hydro

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MEMORANDUM

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March 25, 1991

File No.: 104.21 x 127.63

SUBJECT: Forecast of Electricity Sales for 1991 to 1996

In preparation for the Ontario Energy Board Hearings, we have reviewed the forecast of Basic and Primary electric load for 1991 to 1996 contained in Load Forecast Report 901210. This review included the following activities: (1) examining the recent performance of Load Forecast 901210; (2) re-estimating the monthly state-space model with EPRI's Forecast Master Plus program using a time-series of weather-corrected data updated to the end of January 1991 and preparing the associated forecasts; (3) estimating the single-equation econometric model built with annual data and preparing forecasts using the updated economic outlook dated February 1991; (4) assessing the strengths and weaknesses of the various models in light of recent forecast performance to determine if the Basic Load Forecast should be revised; (5) considering the latest estimates for the net load impact of program-driven Electrical Efficiency Improvement (EEI), Load-Shifting (L-S) and Load Displacement Non-Utility Generation (LD-NUG); and, (6) determining whether the Primary Load Forecast should be revised.

The results are summarized below.

1. Comparison of Actual Load to Load Forecast 901210

The short-term portion of LF901210 was prepared in July 1990 assuming normal weather conditions in the forecast period. The net load impact of demand management was revised in November 1990.

The Primary Load for 1990 was 15,610 Average Megawatts (Av.MW), 3.3% below the forecast of 16,144 Av. MW and 2.9% below the actual for 1989. The cumulative effect of the weather has decreased load by about 1.2% of the forecast for the year. Weather-corrected load for 1990 was 15,807 Av. MW, 0.9% below weather-normal 1989. The forecasted growth rate for 1990 was 1.2% above weather-normal 1989 and 0.5% above actual 1989 load. Thus, at the end of 1990, LF901210 was tracking 2.1% above the primary load that would have occurred under normal weather conditions.

	Primary Energy Av. MW		Primary 1-Hour Peak MW	
	1989	1990	1989	1990*
Actual	16,070	15,610	24,377	21,758
Weather-Corrected	15,954	15,809	23,368	22,491
LF901210		16,144		23,704

* The weather-corrected primary 1-hour peak for 1990 was set in January at 24,166 MW. For purposes of comparison with the Load Forecast for the second half of 1990, the December peak results are given above.

LF901210 was produced assuming roughly flat growth in real GDP for the second half of 1990. Real economic growth was much weaker than that, declining by over 4.0 per cent in October and November. In addition, major strikes in the steel and pulp paper industries reduced total primary load in 1990 by around 1.0 per cent.

The 1990 Short-term Load Forecast for 1991 called for Basic growth of 2.0% and Primary growth of 1.5% over weather-normal 1990. Since the actual values for 1990 were below the forecast, LF901210 now projects primary load growth in 1991 to be 3.6% over the 1990 weather-corrected actual and 5.0% over observed 1990 load.

2. Results of the State-Space Model

The Load Forecasts Department is now basing its monthly model forecast purely on the state-space methodology. This model has performed very well for the past three years. Its multivariate approach makes it more flexible than the univariate Box-Jenkins technique. Nonetheless, the forecasting performance of monthly multivariate time-series models is considered to deteriorate beyond 18-24 months in the future.

The state-space model update has the same specification as was used to prepare the 1990 Short-term Load Forecast. Revised data sets were developed for the two explanatory variables, Ontario GDP and the value of residential building permits. The dependent variable is the time-series of the historical values for monthly weather-corrected Ontario basic energy. Until the end of 1988, basic load and primary load data are the same. In 1989 and 1990, basic energy is obtained from the observed primary load data by adjusting the primary energy series for the estimated net impact of Hydro's demand management efforts.

In order that the load lost temporarily due to strikes between August and December 1990 not bias the forecast for 1991 down, the estimated impact of the strikes was added back on to the observed load for modelling purposes only. These estimates were derived in consultation with Regional staff familiar with the affected industries.

The model has been quite sensitive to the economic situation experienced by the province in 1990 and is responding to the downward revision in GDP and housing starts in the February 1991 economic outlook relative to the July 1990 forecast. On the other hand, the end of the strikes which exacerbated the decline in load in the second half of 1990, provides a boost to load over 1990 levels. The

State-Space forecast for 1991 is 2.8% below the level for Basic Load contained in LF901210. (See Table in next section).

Despite the recovery of GDP growth rates in 1992 and 1993, the state-space model forecasts for those years are still dominated by the weak load growth rates of 1990. These forecasts are not considered to adequately capture the expected cyclical recovery in electricity sales and so the emphasis for forecasting beyond 1991 is placed on the annual model results.

Economic Forecast Comparison

	July 1990		February 1991	
	Ontario GDP*	Housing Starts**	Ontario GDP	Housing Starts
1990	0.5	70.4	-0.6	62.6
1991	1.8	62.5	-0.4	54.0
1992	3.9	69.2	3.0	61.0
1993	3.5	75.8	4.0	68.0
1994	3.0	73.9	4.5	73.9

* Real Growth (%)
** Thousands of Units

3. Results of the Annual Short-Term Forecasting Models

The annual econometric models are estimated on basic energy data that is not weather-corrected as heating and cooling degree day variables are included as explanatory variables in the equations. Weather effects on a calendar year basis were extreme in 1990 and may not be adequately captured by the model coefficients. The year 1990 was also unusual because of the decline in load growth and the significant impact of strikes. As the major purpose of the annual models in this forecast is to project the level of load in 1992-1996, it was judged that inclusion of 1990 data in estimation and forecasting would distort the results for those years.

This is consistent with the experience of the early 1980's which indicated that forecasts made just prior to the recession of 1982 performed better in the mid-1980's than the ones made right after the recession. Thus, to avoid repeating the downward bias introduced by starting to project from the trough of the cycle, the annual models were forecast from 1989. The difference between basing the forecast on data to 1989 rather than on data to 1990 is about 300 Av. MW per year.

No specification changes were made to the partial adjustment and error correction models used in the July 1990 load forecast. Even with the actual GDP data for 1990, the annual models overforecast that year by about 2%. The partial adjustment equation forecast grows much more slowly than that of the error correction model until about 1995. In 1992, the two forecasts are already 3%

apart. The gap grows to 4.2% in 1993, but by 1996 the two forecasts differ by only 1.5%.

The goodness-of-fit statistics are very close for the two models but the error correction model has lower ex-post forecasting errors than the partial adjustment model in the time frame relevant to the rate case. The error-correction model forecasts were the major input to the forecasts for 1992-1996.

Results for the 1991 Update to
Short-Term Basic Load Forecast (LF901210)

(Annual % Growth in Energy - Av. MW)

	LF901210 Av. MW	State-Space Av. MW	Error Correction Av. MW	Partial Adjustment Av. MW
1991	16590 (4.3%*)	16127 (1.4%)	16330 (2.6%)	16173 (1.7%)
1992	17322 (4.4%)	16337 (1.3%)	16780 (2.8%)	16288 (.7%)
1993	17824 (2.9%)	16568 (1.4%)	17302 (3.1%)	16598 (1.9%)
1994	18316 (2.8%)	-	17873 (3.3%)	17120 (3.1%)
1995	18868 (3.0%)	-	18430 (3.1%)	17848 (4.3%)
1996	19510 (3.4%)	-	19017 (3.2%)	18735 (5.0%)

*The 1991 forecast was 2.0 per cent above forecasted 1990 but is 4.3 per cent above estimated 1990 Basic energy of 15,909 Av. MW.

4. Recommended Short-Term Basic Load Forecast - January 1991 Update

The forecast of 16147 Av. MW for 1991 is based on the state-space model projection and is equivalent to 1.5% growth over the weather-corrected basic for 1990. The state-space model is considered to provide the best forecast for the first twelve months, taking account of weather, strikes and the turning point in Ontario GDP.

The level of basic load in 1992 was set considering the results of the annual econometric models in the context of the previous recovery year in 1983. As the

partial adjustment forecast is even lower than the state-space result for 1992, it was rejected. The error correction model implies nearly 4% growth relative to the recommended 1991 load forecast. This was considered high, given the 1:1 ratio of load growth to GDP growth observed in 1983. The recommended forecast of 16630 Av. MW is the result of scaling back to a 3% growth rate applied to the recommended 1991 level.

The forecasts for 1993-1996 are designed to return the short-term load forecast to the long-term growth path, as the perturbation caused by the recession in 1990-91 is not expected to alter the long-term potential economic growth of the Province of Ontario. It is expected that the economic output and its associated load that is lost in 1990 and 1991 will be recovered in the years ahead as the present downturn is considered to be largely cyclical rather than structural in nature. The general trajectory of the recommended forecast tracks slightly above that of the error correction model. The forecast growth rates have been deliberately kept to round numbers to reflect the high degree of judgment entailed in a forecast of the path of cyclical recovery made from the trough of a cycle.

Recommended Short-Term Basic Load Forecast (Update)

	Basic Energy (Av.MW)	Annual % Growth
1991	16147	1.5
1992	16630	3.0
1993	17212	3.5
1994	17901	4.0
1995	18617	4.0
1996	19361	4.0

5. Estimates of the Net Load Impact of EEI, L-S, and LD-NUG Programs

The estimated net impacts of EEI, L-S and LD-NUG programs for the years 1991-1996 were prepared in November 1990 and were included in Chapter 6 of the 1990 Load Forecast Report. However, the impact of the recent government directives in the area of demand management have not yet been taken into account. When the evaluation of the impact of increased funding over the next 5 years is completed, the findings may suggest further changes to the Recommended Primary Load Forecast.

6. The Recommended Primary Load Forecast for HR-20

The Recommended Primary Load Forecast is contained in Table 1. It is derived from the Recommended Basic Load Forecast and the projected impact of EEI, L-S and LD-NUG programs as revised in November 1990. The updated forecast decreases primary energy by 429 Av.MW or 2.6% in 1991 and 688 Av.MW or 4.0% in 1992.

The estimated 1989 Basic Load is derived by adding the estimated LD-NUG, EEI and L-S impacts to the actual primary load for 1989. The estimated 1990 Basic load is derived by adding to the actual 1990 primary load the estimated program impacts for 1989 and the forecasted program impact values for 1990. The final 1990 impact estimates are not yet available.

Tables 2.1 and 2.2 compare the primary peak and energy forecasts made in LF901210 with the update.

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Economics & Forecasts Division

ML:bf

Attach.

cc Ms. Malen Ng
Messrs. Paul Murphy
Bob McRae
Bryan Boyce
Mark Lackey

Table 1: 1990 Short-Term Forecast - Derivation of Primary from Basic

December Peak - MW (1-Hour)

Year	Basic	Annual Growth MW	Annual Growth %	EEI	L-S	LD-NUG	Primary	Annual Growth MW	Annual Growth %
1989*	23524	591	2.6	36	62	58	23368	435	1.9
1990**	24495	971	4.1	131	139	59	24166	798	3.4
1991	23901	-594	-2.4	261	214	65	23361	-805	-3.3
1992	24774	873	3.7	408	289	84	23992	631	2.7
1993	25667	893	3.6	564	367	112	24624	631	2.6
1994	26782	1115	4.3	721	448	133	25480	856	3.5
1995	28066	1284	4.8	882	532	152	26499	1019	4.0
1996	29302	1236	4.4	1069	622	170	27441	942	3.6
Avg % Inc									
1989-95		757	3.0				2.1	522	2.1
1990-95		714	2.8				1.9	467	1.9

Energy - GW.h

Year	Basic	Annual Growth Mw	Annual Growth %	EEI	L-S	LD-NUG	Primary	Annual Growth Mw	Annual Growth %
1989*	139889	5494	4.1	53	0	79	139758	5363	4.0
1990	139367	-522	-.4	537	0	343	138487	-1271	-.9
1991	141448	2081	1.5	1212	0	484	139753	1266	.9
1992	146078	4630	3.3	2042	0	624	143413	3660	2.6
1993	150777	4699	3.2	2934	0	834	147009	3596	2.5
1994	156813	6036	4.0	3850	0	988	151975	4966	3.4
1995	163085	6272	4.0	4779	0	1128	157178	5203	3.4
1996	170067	6982	4.3	5806	0	1261	162998	5820	3.7
Avg % Inc									
1989-95		3866	2.6				2.0	2903	2.0
1990-95		4744	3.2				2.6	3738	2.6

Energy - Av. MW

Year	Basic	Annual Growth Mw	Annual Growth %	EEI	L-S	LD-NUG	Primary	Annual Growth Mw	Annual Growth %
1989*	15969	669	4.4	6	0	9	15954	654	4.3
1990	15909	-60	-.4	61	0	39	15809	-145	-.9
1991	16147	238	1.5	138	0	55	15954	145	.9
1992	16630	483	3.0	232	0	71	16326	373	2.3
1993	17212	582	3.5	335	0	95	16782	455	2.8
1994	17901	689	4.0	439	0	113	17349	567	3.4
1995	18617	716	4.0	546	0	129	17943	594	3.4
1996	19361	744	4.0	661	0	144	18556	614	3.4
Avg % Inc									
1989-95		441	2.6				2.0	331	2.0
1990-95		542	3.2				2.6	427	2.6

* 1989 and 1990 Primary is W.C. Actual
** 1990 Primary 1-Hour Peak occurred in January. Other values are December 1990

Table 2.1: Primary 1-Hour Peak Demand - Comparison of Update and LF901210

Year	Update		LF901210		Change from LF901210	
	MW	%	MW	%	MW	%
1989	23368*		23368			
1990	24166*	3.4	23704	1.4	462	1.9
1991	23361	-3.3	23922	.9	-561	-2.3
1992	23992	2.7	24968	4.4	-976	-3.9
1993	24624	2.6	25525	2.2	-901	-3.5
1994	25480	3.5	26097	2.2	-617	-2.4
1995	26499	4.0	26889	3.0	-390	-1.5
1996	27441	3.6	27563	2.5	-122	-.4
Avg Inc						
1990-1995		1.9		2.6		
1990-1996		2.1		2.5		

* Actual Weather-Corrected

Table 2.2: Primary Energy Demand - Comparison of Update and LF901210

Year	Update			LF901210			Change from LF901210	
	AV.MW	TW.h	%	MW	TW.h	%	TW.h	%
1989	15954*	139.8		15954	139.8			
1990	15809*	138.5	-.9	16144	141.4	1.1	-2.9	-2.1
1991	15954	139.8	.9	16383	143.5	1.5	-3.7	-2.6
1992	16326	143.4	2.6	17012	149.4	4.1	-6.0	-4.0
1993	16782	147.0	2.5	17399	152.4	2.0	-5.4	-3.5
1994	17349	152.0	3.4	17784	155.8	2.2	-3.8	-2.4
1995	17943	157.2	3.4	18236	159.7	2.5	-2.5	-1.6
1996	18556	163.0	3.7	18703	163.8	2.6	-.8	-.5
Avg Inc								
1990-1995			2.6			2.5		
1990-1996			2.7			2.5		

* Actual Weather-Corrected

APPENDIX 1

Error Correction Model:

$$Ln(Av.MW_{(t)}) = C_1 + C_2 * Ln(GDP_{(t)}) + C_3 * Ln(GDP_{(t-1)}) + (1-C_2-C_3) * Ln(Av.MW_{(t-1)}) + C_4 * Ln(PELGST_{(t)}) + C_5 * Ln(HDD_{(t)}) + C_6 * Ln(CDD_{(t)})$$

The estimated results of this model are as follows:

	Parameter	T Statistic	Standard Error
C_1	-0.9768980	-2.0529587	0.4758488
C_2	0.5100747	5.8708283	0.0868829
C_3	-0.4397136	-4.0783955	0.1078153
C_4	-0.0411851	-2.0392410	0.0201963
C_5	0.1083324	2.1902346	0.0494615
C_6	0.0235985	2.0078742	0.0117530

Sample Period - 1963 - 1989

R-squared	0.999372	Mean of dependent var	9.127318
Adjusted R-squared	0.999222	S.D. of dependent var	0.380008
S.E. of regression	0.010598		

Elasticity	Short Run	Long Run
Price of Electricity	-0.0412	-0.5853
Price of Gas	-	-
GDP	0.5101	1.0000

Partial Adjustment Model:

$$Ln(Av.MW_{(t)}) = C_1 + C_2 * Ln(PELGST_{(t)}) + C_3 * Ln(PGASGST_{(t)}) + C_4 * Ln(GDP_{(t)}) + C_5 * Ln(Av.MW_{(t-1)}) + C_6 * Ln(HDD_{(t)}) + C_7 * Ln(CDD_{(t)})$$

The estimated results of this model are as follows:

	Parameter	T Statistic	Standard Error
C_1	-1.66782	-3.282	0.508174
C_2	-0.171943	-3.404	0.0505063
C_3	0.0818425	2.696	0.0303605
C_4	0.497495	6.586	0.0755331
C_5	0.606834	11.534	0.0526115
C_6	0.0468452	0.900	0.052032
C_7	0.0215055	1.718	0.0125181

Sample Period - 1963 - 1989

R-squared	0.999415	Mean of dependent var	9.127318
Adjusted R-squared	0.999239	S.D. of dependent var	0.380008
S.E. of regression	0.010482		

Elasticity	Short Run	Long Run
Price of Electricity	-0.1719	-0.4373
Price of Gas	0.0818	0.2082
GDP	0.4975	1.2654

APPENDIX II

MODELS USED IN PREPARING THE 1991 SHORT-TERM LOAD FORECAST

Appendix 2

2.1 Monthly Models

The Load Forecast Department's monthly models have been prepared using software, called Forecast Master Plus, developed under contract to the Electric Power Research Institute. Two of the more sophisticated options in the package have been utilized here: State Space and Box-Jenkins. Hydro's results with the relevant models are presented below.

The State Space model is the most comprehensive in its use of pertinent information and generally shows the best performance in terms of ex-post tests. It is Hydro's preferred methodology for monthly forecasting. The Box Jenkins model uses only the history of the data series to be forecast, hence its forecast shows a reliable continuation of current trends, and it is therefore valuable as a reference check against other results.

State Space Model

A linear State Space model of a time series consists of two equations. The first, called the state transition equation, is an updating function for the state vector which consists of all the information from the past relevant to forecasting the future. The second equation is the prediction equation which forecasts for each period based on the updated information set from the first equation and the history of the system to date.

The State Space methodology relies on the analyst to specify the input variables on the basis of economic theory. Model diagnostics may be used to assess the appropriateness of the specification postulated in relation to other State Space models. It is not a structural model, in the sense that the parameters estimated represent an observable quantity, but is a well-accepted methodology that has been verified to be useful by both academics and practitioners in forecasting. In ex-post tests, this model proved to be the best of the several methods available. It responds to the most recent trends in the data (over the final years of history) and adapts to the seasonal patterns.

The State Space model preferred this year has seasonally adjusted, real provincial GDP and an index of the real value of residential building permits as input variables. Both the WCTSEBST (weather-corrected total system basic energy), and the residential building permit index and the monthly provincial GDP series are log-transformed, first simple differenced and first seasonally differenced. The order of the model (corresponds to the dimension of the matrix of the coefficients of the updating equations) is one.

A summary of the estimated results for the State Space model follows.

State Space model for WCTSEBST

Number of Observations:	221	Complexity:	6.00
Mean of Log(WCTSEBST):	9.398828	Standard deviation:	0.200454
Standard forecast error:	0.013716	RMS error:	0.013529
Adjusted R-square:	0.995318	R-square (corrected for mean):	0.995424
Durbin Watson statistics:	2.1076	Ljung-Box: Chisq(18) =	67.19 (1.00)**
Akaike criterion(AIC):	167.8428	Schwarz criterion (BIC):	175.766563

Variable	POW	D	S	Coefficient
WCTSEBST	LOG	1	1	Endogenous
Seasonal SS parameters:				
A[1]				0.053588
K[1]				-0.574303
Short memory SS parameters:				
A[1]				0.384175
K[1]				-0.342420
GDP9107	LOG	1	1	Exogenous
G[1][1]				0.151317
BP9107[-6]	LOG	1	1	Exogenous
G[1][2]				0.007097

No constant

Box-Jenkins Model

This methodology uses only the patterns contained in the data history to prepare a forecast. No assumptions about cause and effect are made and no economic theory is used in this model; only the variable to be forecast is included in the data used for modelling. Once the model is estimated based on all the significant inter-temporal correlations in the recorded history, the most recent data is used to start the replication process which produces forecasts for the future.

The data series is log transformed, first simple differenced and first seasonal differenced, and then the remaining time series is modelled. The optimal functional form is determined to be moving average in the first and twelve-period on the remaining series.

Box-Jenkins Model for WCTSEBST

Number of observations:	233	Complexity:	2.00
Mean of Log(WCTSEBST):	9.379979	Standard deviation:	0.212301
Standard forecast error:	0.013714	RMS error:	0.013655
Adjusted R-square:	0.995827	R-sq (corrected for mean):	0.995845
Durbin-Watson statistic:	1.987071	Ljung-Box: Chisq(18) =	45.05 (1.000)**
Akaike criterion (AIC):	163.185514	Schwarz criterion (BIC):	165.620496

Variable	POW	D	S	Coefficient	Std. Error	T-statistics	Prob.
WCTSEBST	LOG	1	1	Endogenous			
b[1]				0.342282	0.0832992	4.109	1.000
B[12]				0.663724	0.0504809	13.148	1.000

No constant

2.2 Annual Econometric Models

Error Correction Model

Assumptions: The assumption of Constant Return to Scale (CRS) with respect to GDP was imposed - statistically this asssumption cannot be rejected.

Model:

$$Ln(Energy) = C_1 + C_2 * Ln(GDP) + C_3 * Ln(GDP(-1)) + (1-C_2-C_3) * Ln(Energy(-1)) + C_4 * Ln(PELGST) + C_5 * Ln(HDD) + C_6 * Ln(CDD)$$

The estimated results of this model are as follows:

	Parameter	T-Statistics	Standard Error	2-Tail Sig.
C_1	-0.9768980	-2.0529587	0.4758488	0.053
C_2	0.5100747	5.8708283	0.0868829	0.000
C_3	-0.4397136	-4.0783955	0.1078153	0.001
C_4	-0.0411851	-2.0392410	0.0201963	0.054
C_5	0.1083324	2.1902346	0.0494615	0.040
C_6	0.0235985	2.0078742	0.0117530	0.058

Sample Period - 1963-1989

R-squared	0.999372	Mean dependent var	9.127318
Adjusted R-squared	0.999222	S.D. of dependent var	0.380008
S.E. of Regression	0.010598	Sum of squared resid	0.002359
Durbin-Watson Stat.	2.513172	F-Statistic	6681.362
Log Likelihood	87.85276		

Elasticity	Short Run	Long Run
Price of Electricity	-0.0412	-0.5853
Price of Gas	-	-
GDP	0.5101	1.0000

Partial Adjustment Model

The model was estimated with an additive time trend.

Model:

$$ENERGY = PELGST^{C_1} * PGASGST^{C_2} * GDP^{C_3} * ENERGY(-1)^{C_4} * CDD^{C_5} + TIME*C_6$$

The estimated results of this model are as follows:

	Parameter	T-Statistics	Standard Error	2-Tail Sig.
C_1	-0.1170731	-4.8634183	0.0240722	0.000
C_2	0.0269025	1.7061349	0.0157681	0.103
C_3	0.5330018	7.1206221	0.0748533	0.000
C_4	0.4614748	5.8812472	0.0784655	0.000
C_5	0.0151241	1.3103038	0.0115425	0.204
C_6	99.1124625	4.0003328	24.776054	0.001

Sample Period - 1963-1989

R-squared	0.999384	Mean dependent var	9816.404
Adjusted R-squared	0.999238	S.D. of dependent var	3370.607
S.E. of Regression	93.06976	Sum of squared resid	181901.6
Durbin-Watson Stat.	2.021661	F-Statistic	6816.083
Log Likelihood	-157.3190		

Elasticity	Short Run	Long Run
Price of Electricity	-0.1171	-0.2174
Price of Gas	0.0269	0.0500
GDP	0.5330	0.9897

Table B2.1

Comparison of Model Forecasts and Customer Survey Results
July 1991 Short-Term Forecast

Total Basic Energy in Average MW							
Year	1990 Fcst LF901210	Monthly Models		Annual Models			
		State - Space		Error Correction	Partial Adjustment	Customer Survey	Recommended Basic
		Box-Jenkins	State-Space				
1991	16575 2.0%	16069 1.01%	16042 .83%	16223 1.98%	16139 1.45%	16057 .93%	16147 1.50%
1992	17321 4.5%	16537 2.91%	16533 3.06%	16713 3.02%	16365 1.40%	16639 3.62%	16630 2.99%
1993	17822 2.9%	16923 2.33%	16979 2.70%	17207 2.95%	16781 2.54%	17188 3.30%	17212 3.50%
1994	18309 2.7%			17744 3.12%	17326 3.25%	17729 3.15%	17780 3.30%
1995	18856 3.0%			18312 3.20%	17989 3.83%	18251 2.94%	18402 3.50%
1996				18916 3.30%	18718 4.05%	18780 2.90%	19065 3.60%

APPENDIX III

WEATHER CORRECTION OF MONTHLY ELECTRICITY CONSUMPTION

Weather Correction of Monthly Electricity Consumption Data

Purpose

The purpose of the weather correction to historical data is to remove variance considered to be noise by the forecaster. The electricity consumption forecast is made on the assumption of ordinary seasonal weather. Short term weather fluctuations affect the consumption of electricity by an amount which can not be forecasted for the future beyond a few days, and therefore will not be incorporated in a monthly electricity consumption forecast. These fluctuations result in variation of typically up to 440 average MW on a monthly basis.

In the estimation of a model to be used for forecasting, the variance due to fluctuations of weather is noise which increases the error of estimation in the coefficients and can lead to an incorrect choice of model from the many under consideration. The prediction error of any chosen model is also increased by this noise since the weather influence is uncorrelated with the explanatory variables used in the model.

Definitions

Weather corrected energy is that energy use which would have been expected to occur during the period had the average weather effect been equal to its long term average value.

Weather corrected peak is that peak which would have been expected to occur during the period had the variability of the weather effect been equal to its long-term value.

Method

The method to correct actual recorded electricity consumption for the influence of weather is first to determine the amount by which the actual weather measures have deviated from the ordinarily expected amounts and second to calculate the electricity consumption deviation due to the weather deviations, taking into account the expected fluctuations of weather over the time period under consideration.

To do this a thirty year data base of all weather measures is maintained from the records made for Pearson International Airport. This is used as the source of the long run expected weather.

The correction system uses average daily values of the weather measures. Estimation of piecewise linear models for days classified into different sub- populations by cooling or heating type is carried out, correcting for holidays, cycles and other such known effects. Once this is done, coefficients for the electricity consumption versus weather measure are available for correction of actual consumption by the weather effect experienced that day.

Estimation of the correction model coefficients for the seventeen years of history to be used in the estimation of monthly models by the Forecast Master system was done in four year blocks, rolling year to year. Correction figures for each year's months were obtained from the midpoint of the current four year model or the end, as appropriate.

The weather variables incorporated are as follows:

Heating Season

Temperature (average of 24 hours)	today	T
" " " "	yesterday	T24
" " " "	day before yesterday	T48
Illumination (by insolation meter)	today	I
Wind Speed	today	W

Cooling Season

Temperature	today	T
	yesterday	T24
Humidity (dew point depression)	today	H